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GEOLOGY OF LYON COUNTY, KANSAS.*

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Read before the Academy, at McPherson, December, 1899.

THE section begins with a stratum of coal from fourteen to eighteen inches in thickness on the east line of Lyon county, two miles east and one mile south of Neosho Rapids, where the formation has a dip of about twenty feet to the mile nearly west. Elevation, 1000 feet.

Above the coal is found from six inches to two feet of shale, then an eighteen-inch limestone, eighteen inches of shale, and another limestone of about equal thickness. The limestones referred to are also well exposed in the river at the Neosho Rapids bridge. Thence passing northwest over about forty feet of shale, we find a limestone thirty to forty feet thick. This stone is characterized by rough weathering, many cavities filled with calcite crystals, a conglomerate appearance, and clusters of *Fusulina cylindrica.* On account of its proximity to Neosho Rapids, it has been designated the Neosho limestone until it may be identified as a stone previously named elsewhere. A good exposure of this stone is found in Rock cut three-quarters of a mile west of Neosho Rapids. It is also well exposed in the ravines to the north and northeast, and is also found forty feet thick in a well at the foot of Chicago mound, five miles southwest of this locality.

Above this stone is twenty-two feet of arenaceous shale approximating sandstone in places, then a two-foot limestone containing concretionary nodules averaging two inches in diameter. These nodules are mostly constituted of oxide of iron, but some are found which carry a small quantity of zinc sulphide. This stone is well exposed in Chicago mound and the ravines north of Neosho Rapids, in Badger creek, north side section 11, township 19, range 12, and Coal creek. Two feet beneath this stone is a stratum of coal six inches thick, which I take to be a remnant of the Osage City coal.

Between this and the Burlingame limestone is thirty feet of shale and sandstone. The Burlingame limestone is well exposed at Humphrey's ford, six miles southeast of Emporia, where it has a dip of eighteen feet to the mile, 70° west of north, and passes under the river about two miles farther up.

Passing up the bluff seventy-five feet, at Humphrey's ford we find, above the Burlingame limestone, nine feet of yellow and blue shale, one foot of limestone, fourteen feet of shale, seven feet friable limestone, which is overlaid in places with a mass of excellently preserved specimens of *Streptorhynchus crenistria*, 13½ feet of blue and yellow shale, calcareous in places, three feet hard blue limestone, with a seam six inches from the top. This stone I have designated the Emporia blue. The six-inch top layer makes a good quality of flagstone, which is extensively used in Emporia. Above this is four feet of slaty shale and another hard blue limestone, agreeing paleontologically and lithologically with the one below.

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* Map and sections illustrating this article will be found in volume XVII of the Academy's Transactions.

These stones, with a dip of sixty-five feet in four miles, pass under the Cottonwood river at Soden's mill, one mile south of Emporia, and are found in wells forty feet below the surface in the city; also in the Neosho river, at Rinker's bridge, three miles northeast, and are extensively quarried in section 14, township 20, range 12, and sections 6, 9, 30, and 31, in township 19, range 12, and section 12, township 19, range 11, and near Olpe, Reading, and Salt creek.

Above these stones is ten feet of shale, a twelve-inch limestone, eight feet more shale, and a five-inch coal stratum, which is exposed in the banks of Dry creek, three miles south of Emporia, and on Coal creek, a few miles farther south, where it is three inches thicker, and has been stripped for local consumption. The forty feet of shale which overlays the coal is quite variable in character, being carbonaceous in places; in others, sandy, calcareous, or argillaceous. A very productive horizon of fossil flora lies near the top of this bed. In the sandy portions good examples of drift bedding are often exposed. A five-foot sandstone near the top is separated from the Emporia system by five feet of buff shale. Overlying this, on the north side of the river, is the Emporia system of limestones, composed of five members from one to two feet in thickness, with intervening shale beds from four to ten feet thick. This system is best exposed in the ravines and hillsides sloping to the Neosho river just northwest of Emporia, where, in some places, they have a local dip to the north of fifty feet to the mile.

South of the Cottonwood river the character of this system is very different, being mainly a mass of fragmentary limestone five to eight feet thick, with the crevices filled with clay. A good exposure of this condition is found in the southeast quarter of section 29, township 19, range 11.

Above the Emporia system is twenty-seven feet of sandy shale and sandstone with *Myalina subquadrata* near the top; then an eighteen-inch siliceous limestone streaked with red, containing *Pinna peracuta;* then another sandy shale bed forty-seven feet thick, which is overlaid with ten inches of coal.

This coal is exposed eight miles southwest of Madison, in Greenwood county, and in Lyon county on the Verdigris river, section 34, township 21, range 10; on Shaw creek, Rock creek, and Moon creek, in the southwest part of the county; near Phenis mound in section 1, township 20, range 10; in Reservoir hill, near Emporia, near the center of section 30, township 18, range 11; on Stillman creek, seven miles north of Emporia, in section 4, township 18, range 12; in the northeast corner of section 30, and west side of 33, township 17, range 12; two miles east of Admire, on One Hundred and Forty-two creek; and on Elm creek, in section 33, township 15, range 12. The thickness of this coal varies but little in the entire distance that I have traced it. It has been stripped for local trade in a number of places. It burns well, but contains an excessive amount of ash — amounting to over twenty per cent. The dumps where this coal is stripped always contain many *Myalina subquadrata.* The shales near this coal yield small quantities of oil and gas in at least ten places in the county. Overlying the coal is ten feet of sandy shale, one foot limestone containing *Myalina subquadrata,* eleven feet of sandy shale and sandstone containing ripple-marks, eighteen inches limestone, fifteen feet shale, two feet limestone, fourteen feet shale, five feet calcareous shale, seven feet shale with cone-in-cone structure, ten inches limestone, ten feet shale with thin coal seam, two feet limestone, and forty-five feet of shale containing red sandstone in places, which brings us to the Americus system, consisting of one foot limestone which weathers to *dry-bone* formation, eight feet shale, twenty-one inches good building stone, containing many *Fusulina* of the robust type, six feet shale, and a six-inch flag limestone. The shale on either side of this stone contains an abundance of *Fusulina.* The twenty-one-inch stone of this system, known as the Americus limestone, is extensively quarried in the top of the hills south of Americus, and near Allen. The top of Phenis mound, ten miles southwest of Emporia, altitude 1278 feet, is a few feet lower than the Americus stone, which may be seen in the hills to the southwest.

Above this is from eight to twenty-six feet of black, blue and buff shale containing *Retzia mormoni, Rhynconella* sp.? and many crinoid plates and stems, two feet blue limestone containing *Fusulina cylindrica* and *Productus semireticulatus,* four feet calcareous shale, eighteen inches *Fusulina* limestone, four feet shale, one foot limestone containing *Myalina subquadrata* and *Archæocidaris* spines, ten feet nine inches shale, to a friable *Fusulina* limestone eight feet thick, embracing a twelve-inch shale stratum. This stone is exposed in the bluff at Elmdale mills, Chase county, and is level with the bridge spanning the river at that place, thirty feet above the water. In the bluff south of Saffordville it is sixty feet above the river. Good exposures are found at Allen and many other places in the county. It is one of the easiest formations to trace, on account of the soil being strewn with countless numbers of *Fusulina cylindrica* of the robust type for some distance below the outcropping margin. The top four feet of this stone is heavy bedded and contains crinoid stems and *Polyzoa*, but fewer *Fusulina*. Above this stone is ten feet of buff shale, one foot of limestone, six feet of blue shale, six feet of buff shale, six feet of heavy bedded limestone with *Archæocidaris* spines, five feet of shale, eight inches of shelly limestone, thirteen feet seven inches blue and yellow shale, three feet of limestone, six feet four inches of buff shale, six inches of limestone, three feet eight inches of shale, four feet of thin bedded limestone, parts of it having a porcelain appearance (this appearance is characteristic and has been observed in many places in both counties), four feet two inches buff shale, eighteen inches limestone, six feet two inches blue and yellow shale, twelve feet limestone which weathers very rough, eighteen feet or more of shale, to the Cottonwood Falls stone. This line is the top of Prosser's Wabaunsee formation.

The Cottonwood formation embraces the Cottonwood Falls stone, six feet six inches thick, and the twelve-foot fossiliferous shale bed above it. The Neosho formation overlying the Cottonwood is well exposed in Crusher hill, one and one-half miles west of Strong City, and has been so well described by Prosser and others that a detailed description need not be given here. No. 2 gives a reasonably accurate section of the hill, which is capped by a flinty limestone from twenty to forty feet thick, which corresponds with the lower flint beds of Hay's Fort Riley section. The dip carries this stone beneath the river valley at Cedar Point, where section No. 1 was obtained, at a bluff three miles northwest of the station. The top of section No. 1 is 1330 feet above sea-level.

From the east line of Lyon county to Emporia the westward dip averages fourteen and a half feet to the mile; from Emporia to Saffordville, nearly twenty feet to the mile; from Saffordville to Strong City, twelve feet to the mile. Strong City is nearly in the trough of a syncline where the Cottonwood Falls stone is level with the railroad-track. Passing west from Strong City, an extensive anticline amounting to over 120 feet is observed, the axis of which is near Elmdale, and apparently trends fifteen or twenty degrees west of north into Morris county and south toward the Flint Hills. Local dips amounting to two or three degrees are frequently found in this area. From a mile or two west of Elmdale to near Clements the usual westward dip is again maintained, while at and west of Clements the dip becomes excessive, amounting to fifty feet per mile, which brings the lower flint beds to the river valley at Cedar Point.

At Saffordville, the Americus stone is a few feet above the water in the river and the Cottonwood Falls stone is in the top of the hills beyond the bluff. A better exposure of nearly the same strata is found at Elmdale mills, fifteen miles farther west, where section No. 3 was obtained. The Americus stone is under the river at this place.

While considerable attention has been given to the paleontology of the district, my collection of fossils is too incomplete and too many are unidentified to warrant publication at this time, and such reference as I have made to fossils has been done only when they appeared to be especially characteristic of the formation and might aid in its identification.